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ABSTRACT

This longitudinal study explored how gestures changed with with respect to speech as two children progressed from producing single words to producing two-word combinations. Two girls were followed from the production of only single words to their first production of two-word combinations. One child was followed from 14.5 to 18 months; the second child was followed from 15.5 to 22 months. Children were videotaped during spontaneous play sessions; both the mother and researcher interacted with the children. All gestures and speech produced by the children were coded. Three analyses of relationships between gesture and speech were conducted. All communications were classified as gesture alone, speech alone, or gesture and speech combined. The timing of the gesture with respect to the speech stream was determined. Finally, relationships between information conveyed by speech and information conveyed by gesture were described. The data collected suggest that the relationship between gesture and speech changes around the time children begin producing two-word combinations. Shortly before the onset of two-word communication, children begin conveying two ideas, one in gesture and one in speech, within the bounds of a single, tightly timed communicative act. Thus, young children appear to demonstrate skills necessary for two-word speech initially in communications which combine gesture and speech. (MM)

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From One Spoken Word to Two: Exploring the Changing Nature of Gesture

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Portions of this paper were presented as part of the symposium, "The Role of Gesture vis-à-vis Speech in Early Child Language," at the 1993 biennial meeting of the Society for Research in Child Development, New Orleans, LA, and as a paper at the 1993 meeting of the Midwestern Psychological Association, Chicago, IL.

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Work by David McNeill (1992) suggests that gestures produced spontaneously with speech serve as an adjunct to speech in adults and in children as young as 2 1/2. Moreover, these gestures are integrated with speech and together the two convey a single message to the listener. Unlike manual systems of communication such as American Sign Language or Signed English (Klima & Bellugi, 1979; Wilbur, 1987), the gestures produced by these individuals do not have a set meaning or form. Rather, these gestures are idiosyncratic to the speaker and to the message the speaker wishes to convey. They are created by the speaker as the utterance unfolds.

Despite the variability in the form and meaning of gestures, McNeill has found that spontaneous gestures have a consistent and describable relationship with speech. Moreover, this relationship has been found across speakers and even across languages (McNeill, 1992). Three features of this system form the cornerstones of this study. First, gesture is almost always produced in combination with speech. Second, a gesture is produced at the same time as the word it is describing. More specifically, the word occurs "on the stroke" of the gesture (Kendon, 1980; McNeill, 1992). For example, if someone wanted to pick out a specific person to refer to in the following sentence, "He went to the store,' the gesture would most likely indicate the person as the word "he" is uttered and not, for instance, the word "store." These two features -- gestures occurring with speech and coordinating with individual words -- describe the temporal integration of gesture with speech. The third feature of this communication system is that gesture, at times, provides information which is additional but related to the information found in speech. For example, if I say "I carried up the box" at the same time as producing a gesture -- two arms held straight out shoulder width apart parallel to the ground -- the gesture provides information not contained in speech about the box, specifically, that it was very big.

In prelinguistic children, gesture often assumes a larger role in the communication system than it does in adults. As an example, Bates (1976) has found that prelinguistic children use pointing gestures several months before beginning to speak. For these children, gesture and speech cannot form an integrated system (since they produce no speech); rather gesture functions independently of speech. As children begin to talk, their gestures do not disappear. We, and others, have found that, even in the "one-word" stage of language development, children produce gestures along with their words (Acredolo & Goodwyn, 1985, 1988; Bates, Benigni, Bretherton, Camaioni & Volterra, 1979; Carter, 1975; Goldin-Meadow & Morford, 1985; Greenfield & Smith, 1976, Morford & Goldin-Meadow, 1992). Apparently, children at this stage continue to use gesture as a supporting system for their communicative needs. The question arises: what is the relationship of gesture and speech in these nascently verbal children? More specifically, when does gesture move from an independent, dominant mode of communication (with respect to speech) to become integrated with, and eventually subservient to, the spoken word?

Two types of early word-gesture combinations have been found to predominate during the "one-word" period of language development. In the first type, gesture is combined with speech and conveys meaning redundant with the meaning of the spoken word; that is, the meaning conveyed by gesture and speech match (for example, pointing at an object and naming it, de Laguna, 1927; Guillaume, 1927; Leopold, 1949; Greenfield & Smith, 1976). In the second type, gesture is combined with speech to add a new semantic element to the meaning of the spoken word; that is, the meanings conveyed by gesture and speech mismatch (for example, holding out a hand as though to receive an object and saying "juice," or pointing at mother's comb and saying "mommy," Greenfield & Smith, 1976; Masur, 1982, 1983; Zinober & Martlew, 1985).

This study explores the nature of the communication system formed by gesture and speech in the early stages of language acquisition. Specifically, we explore how gesture changes with respect to speech as a child progresses from producing single words to producing two-word combinations. We hypothesize the existence of two separate gesture-speech transitions during early linguistic development. The first transition involves moving from independent gesture to a coordinated gesture-speech communication system. This transition, we suggest, will culminate in the production of gesture-speech combinations in which gesture is correctly timed relative to speech. The second transition presupposes the integration of gesture and speech, and suggests that gesture provides the children with a bridge from the production of single words to the production of two-word utterances. Here, we focus on the changes in the nature of the relationship between the information contained in the gesture and the information contained in the speech. Specifically, we hypothesize that the information contained in gesture-speech combinations moves from redundant to supplemental, and that an increase in production of gesture-speech mismatches (where gesture and speech provide different but related information) heralds the onset of two-word speech.

Methods

Subjects and procedure. The subjects for this study were two girls, whom we call Beth and Ann, followed longitudinally from the production of only single words to their first production of two-word combinations. As a result, the final session for each child marks the initial observation of two-word combinations. Beth was followed from 14.5 to 18 months, and Ann was followed from 15.5 to 22 months. All data were collected in videotaped spontaneous play sessions with several bags of toys brought to the child's home; both the mother and the experimenter interacted with the child.

Coding Speech and Gesture. In order to explore the gesture-speech systems of the children, all gestures and speech produced by the children were coded.

Coding speech. All of the vocalizations produced by the children were coded. The children produced three types of vocalizations. First, the children produced words which were interpretable by the experimenters for example, "dog," "cat," or "duck." Second, the children produced vocalizations which were not actual English words, but appeared to be used by the children to reliably refer to a specific object. For example, using "bah" (an imitation of the bark of a dog) to refer to dogs. These two types of vocalizations were combined to form a single category, meaningful vocalizations. The final category contained vocalizations produced by the children which did not appear to be used consistently to refer to a single object or event. These were grouped together in a category labeled "vocalization."

Coding gesture. The gestures typically produced by these children were points, hold-ups, a flat B-palm indicating "give," and two flat B palm-up hands combined with a shoulder shrug indicating "Where is it" or "I don't know." In our system, for a hand movement to qualify as a gesture, the act must meet several criteria. Our criteria for isolating gestures have grown out of a concern that the gestures meet the minimal requirements for a communicative symbol (see Goldin-Meadow & Mylander, 1984, and Butcher, Mylander & Goldin-Meadow, 1991, for discussion) and are as follows: **(1)** The gesture must be directed to another individual; that is, it must be communicative. In particular, we require that the child establish eye contact with a communication partner in order for the child's act to be considered a gesture. **(2)** The gesture must not itself be a direct manipulation of some relevant person or object (i.e., it must be empty-

handed, cf. Petitto, 1988). When a child puts a telephone to the ear and pretends to have a conversation, it is not clear whether that act should be regarded as designating the act of telephoning (and therefore a symbol), or as the child's attempts to practice the act of telephoning (and therefore not symbolic at all, cf. Huttenlocher & Higgins, 1978). To be conservative, we exclude all acts that are done on objects; thus, if a child picks up a toy hammer and pretends to hit an object, that act would not be considered a gesture. In addition, functional acts are not considered gestures, for example, holding out an object to transfer it to another person or reaching for an object. **(3)** The gesture must not be part of a ritual act (e.g., to blow a kiss as someone leaves the house) or game (e.g., patty-cake). In general, the symbolic nature of language allows for a particular type of communicative flexibility: a word can be used for multiple discourse functions. Acts that are tied to stereotyped contexts of use clearly do not have this flexibility and thus are not considered gestures. **(4)** The gesture must not be an imitation of the communication partner's previous gesture. This criterion assures that the child is not merely copying -- with little or no comprehension -- the gestures his or her communication partners produce.

The form of each gesture was described in terms of the shape of the hand, the type of movement, and the place of articulation. In addition, using non-linguistic context, each gesture was assigned a meaning (see Goldin-Meadow & Mylander, 1984, for a detailed description of how meaning is assigned to gestures). In general, gesture interpretation was facilitated by the fact that we are familiar with the toys and the activities that typically occur during the taping sessions, and by the fact that the parents frequently share their intimate knowledge of the child's world with us during the taping sessions. Not only did we use the same set of toys in each taping session, but this set was accessible to the coders when they transcribed the tapes, a procedure which allowed the coders to verify, for example, that a particular toy does indeed have wheels or that the cowboy in a particular picture is in fact holding a gun. In addition, the parents are familiar with the child's own toys and activities outside the taping session and, if we are puzzled by a child's gestures (or speech), we ask the parents during the session what they think the child is looking for, commenting on, etc. The parents' comments, as well as our own, are therefore on tape and are accessible even to coders who are not at the original taping session. Thus context, bolstered by the parents' and our own knowledge of the child's world, constrains the possible interpretations of the child's gestures (and speech) and help to disambiguate the meanings of those communications.

Analyses of the Relationship between Gesture and Speech. After the gestures and speech produced by the children were coded, the following three analyses were conducted.

First, we noted whether a given gesture was produced with speech. All of the child's communications were classified into one of the following categories: gesture alone, speech alone, gesture and speech in combination.

Second, the timing of the gesture with respect to the speech stream was determined for gestures occurring with speech (either meaningless vocalizations or interpretable words); for speech and gestures occurring alone, no further analyses were done. Timing of the gesture with respect to the speech was noted to the nearest videotape frame (1/30 second). Following McNeill (1992), gesture-speech combinations were considered correctly timed if the verbalization occurred on the stroke of the gesture, or if the verbalization occurred at the peak of the gesture, the farthest temporal extension before the hand began to retract.

Third, we described the relationship between the information conveyed by speech and the information conveyed by gesture. All combinations of gestures and words (meaningless vocalizations were eliminated from this analysis) were classified into one of the following categories. Gesture matches the word. In these combinations, gesture and the word contribute redundant information. There are two types of examples which form this category: (1) A child may point at a dog and say "dog;" in this instance, both gesture and speech provide the same information. (2) A mother may ask the child which toy he or she wants and the child says "that" accompanied by a point at the mailbox toy; in this instance, the gesture serves to pick "that" out of the many toys in the situation. Gesture mismatches the word. In these combinations, each modality provided different, but related information to the listener. For example, the child may gesture "give" (a flat palm-up hand extended toward an object, witnout attempting to grab the object) and say "apple;" in this instance, the gesture conveys the transferring action that the child is requesting, and the word conveys the desired object.

Results and Discussion

Stage I We first explored the integration of gesture and speech into a single unified system of communication. We asked if gesture occurred with speech (either meaningful speech or vocalizations) or in the absence of speech. In adults, approximately 95% of gestures produced occur with speech (McNeill, personal communication). We found that the proportion of gestures produced by the children, relative to the total number of communications the children produced, remained relatively stable over this period of development (Figure 1). Therefore, any change in the use of gesture with respect to speech, is not merely a reflection of an increase or decrease in the number of gestures produced, but rather a change in the role gesture plays in the child's communication system.

While the proportion of utterances containing gesture remained relatively stable over development, the way in which children used gesture shifted; in particular, the number of gestures produced alone decreased and the number of gestures produced with speech increased (Figure 2). The proportion of gestures produced in the absence of speech declined steadily over development (top figures). At the same time, the proportion of gestures produced with speech steadily increased (bottom figures). These figures provide a visual description of the shift in gesture production; for both children the proportion of gestures produced in the absence of speech declines and the proportion of gestures produced with speech increases over development.

In adult communication systems in which gesture and speech form an integrated system of communication, words tend to be produced on the stroke of the gesture (McNeill, 1992). For the children, we found initially that the majority of gestures were **not** correctly timed with respect to speech vis-à-vis the adult pattern. Rather, gestures were produced either before speech [point at duck (pause) "duck"] or after speech ["duck" (pause) point at the duck]. Note, that while there was a slight pause in the above combinations, the hand did not relax (had the hand relaxed, these would have been divided into separate utterances). However, for both children, the proportion of correctly timed gesture-speech combinations increased during the transition period **prior** to the onset of two-word utterances (Figure 3).

The data presented thus far are consistent with our hypothesis that the gesture-speech systems of these children were initially not integrated. Rather, gesture appeared to function independently of speech. However, during the one-word stage of language acquisition, gesture and speech began functioning as a single unified system. The

functioning of gesture and speech as a unified system allowed us to explore the relationship between the information conveyed in gesture and the information conveyed in speech.

Stage II. If we presuppose that gesture and speech are indeed functioning as a single communication system, we can explore the information conveyed to the listener by each modality. One could imagine that the use of gesture could increase a child's communication abilities. We specifically explored whether or not gesture provides the child with a bridge or stepping stone in the progression from single words to two-word combinations. In order to do this, we documented the relationship between the information conveyed in gesture and the information conveyed in speech in all gesture-speech combinations. We found initially that all gesture-speech combinations produced by the children contained a meaningless vocalization as opposed to an interpretable word. However, between 16 and 18 months of age, both children began to combine gesture with meaningful words, producing two types of combinations (Table 1). In the first type, gesture matched speech, conveying the same information as the child's word (point at duck + "duck"). In the second type, gesture mismatched speech, that is, it conveyed information which was additional, but related, to that found in speech. For example, one child pointed at a mailbox and said "open" to request that mom open the mailbox. In a second example, one child combined two flat B palm up hands and a shoulder shrug with the word "ball" in order to ask where the ball was (there was no ball visible). In these examples, gesture and speech together conveyed the amount of information typically expressed in a two-word utterance. One might therefore expect this type of gesture-speech combination to precede or co-occur with the onset of two-word combinations. Our data support this hypothesis; the proportion of combinations in which gesture mismatched speech increased five-fold during the session when the children first used two-word combinations (Table 1).

Moreover, in a later videotaped session, when both children were producing frequent two-word combinations, we find additional evidence that the production of gesture-speech mismatches provides a child with a bridge or stepping stone to two-word combinations. Specifically, we found that after the onset of two-word combinations, the number of gesture-speech mismatches produced decreased. For both children, during the session when they produced their first two-word combination (18 months for Beth, 22 months for Ann), gesture-speech mismatches comprised 11% and 13%, respectively, of their gesture-speech combinations. However, at 19.5 months and 25 months, after both children had begun producing frequent two-word combinations, the proportion of gesture-speech mismatches decreased to 4% for both children (Figure 4). These data suggest that the gesture-speech mismatches described here provided the children with a transitory bridge to the production of two-word combinations. It is also important to note that the children continued to gesture once they began combining two words. However, their gestures were no longer produced in mismatching combinations. Once the children were able to convey two different pieces of information through a single modality (speech), the use of gesture for this purpose decreased.

Gesture-speech mismatch as a transitory phenomenon is not unique to the transition from one- to two-word speech. Gesture-speech mismatches have been found in the responses of children acquiring concepts such as conservation and mathematical equivalence (Goldin-Meadow, Alibali & Church, 1993). For these concepts, the production of gesture-speech mismatch appears to signal a child's "readiness to learn," that is, it is a sign that the child is ready to progress to a more sophisticated level of understanding of the concept. In particular, children who produce a relatively large number of gesture-speech mismatches with respect to either conservation or

mathematical equivalence are more likely to benefit from instruction in that concept than children who produce few mismatches (Church & Goldin-Meadow, 1986; Perry, Church & Goldin-Meadow, 1988). The data presented here suggest that developmental change in language, specifically, developmental progress toward two-word combinations, is also heralded by the production of gesture-speech mismatches. Thus, this study, in conjunction with the studies of conservation and mathematical equivalence, suggests that gesture-speech mismatch may be a general index of transition, not only in the acquisition of concepts but also in the acquisition of language itself.

Conclusion

The data presented here suggest that the relationship between gesture and speech changes around the time children begin producing two-word combinations. Shortly before the onset of two-word combinations, children begin conveying two ideas, one in gesture and one in speech, within the bounds of a single, tightly-timed communicative act. Thus, young children appear to demonstrate the skills necessary for two-word speech initially in communications which combine gesture and speech. However, the ability to produce mismatches between gesture and speech presupposes that gesture and speech form a single unified system of communication. The data presented here suggest that the codification of this system occurs late in the one-word stage of language development and precedes two-word speech.

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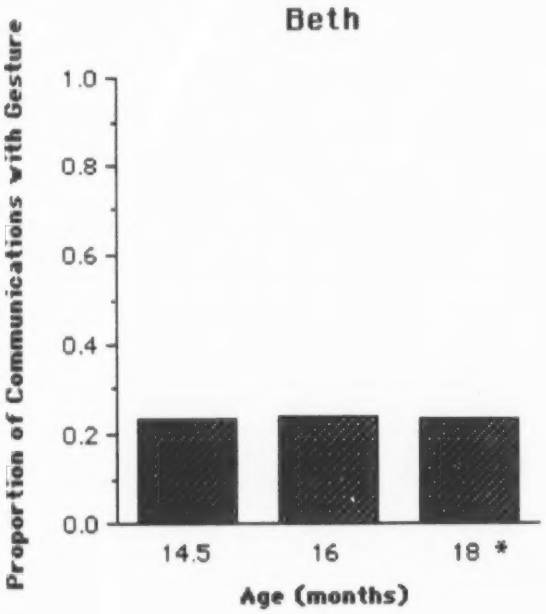
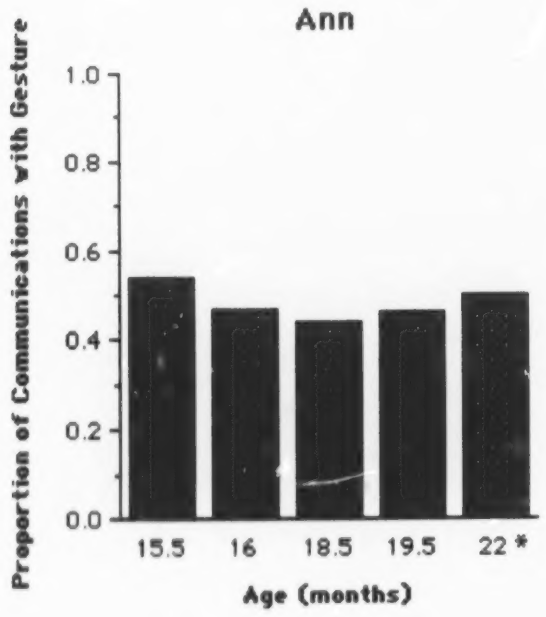
Figure 1

Number of Communications Containing Gesture
(divided by the total number of Communications)

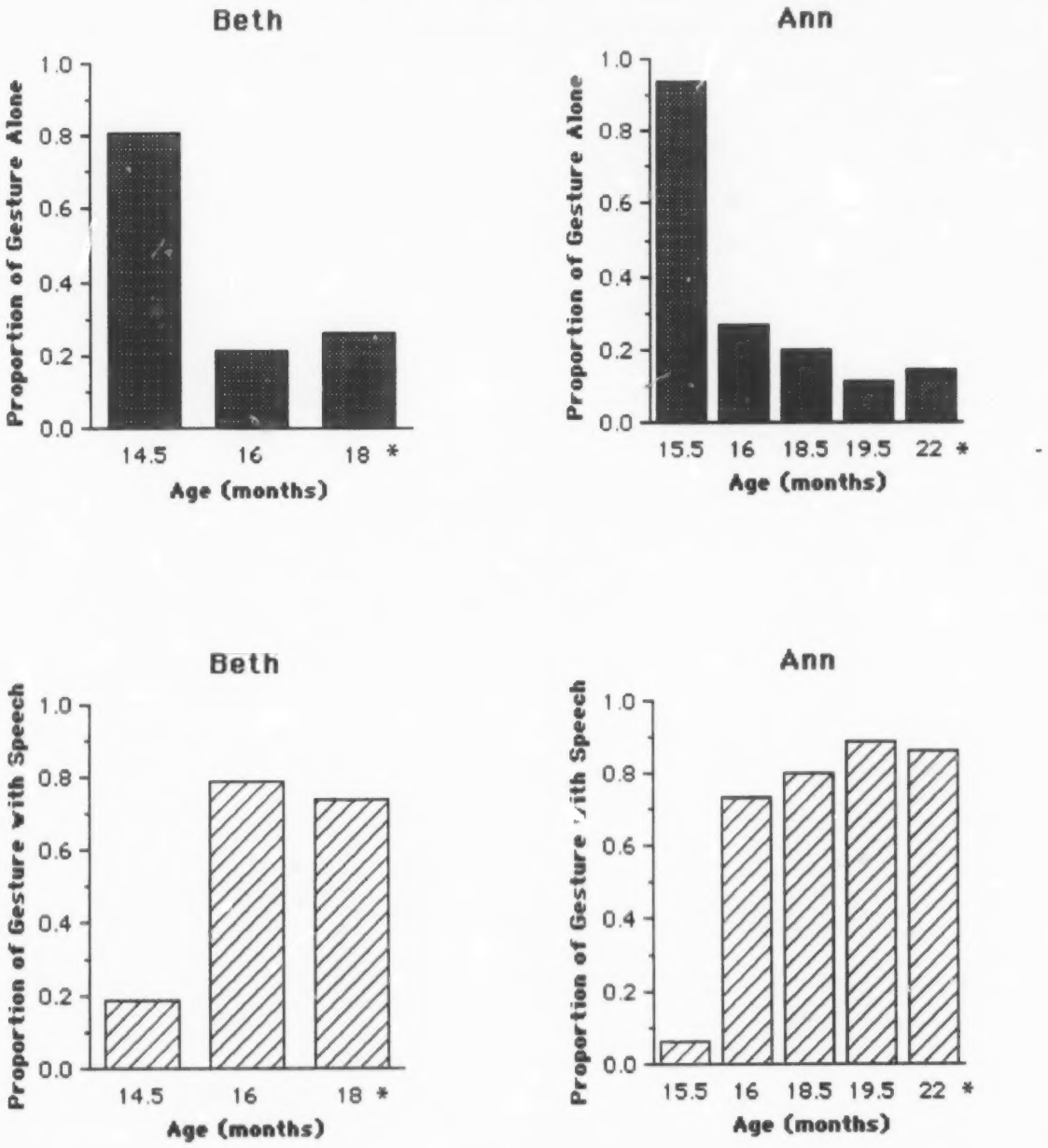




* First evidence of two-word combinations

Figure 2

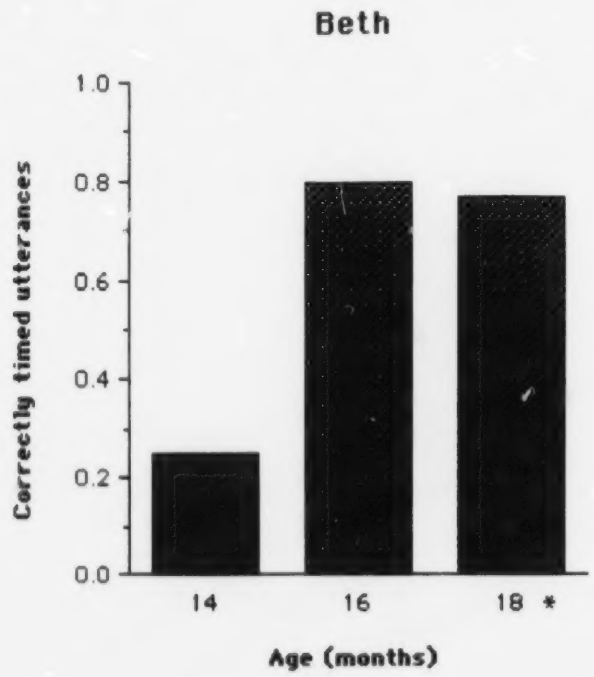
Number of Gestures Produced with and without Speech
(divided by the total number of gestures produced)

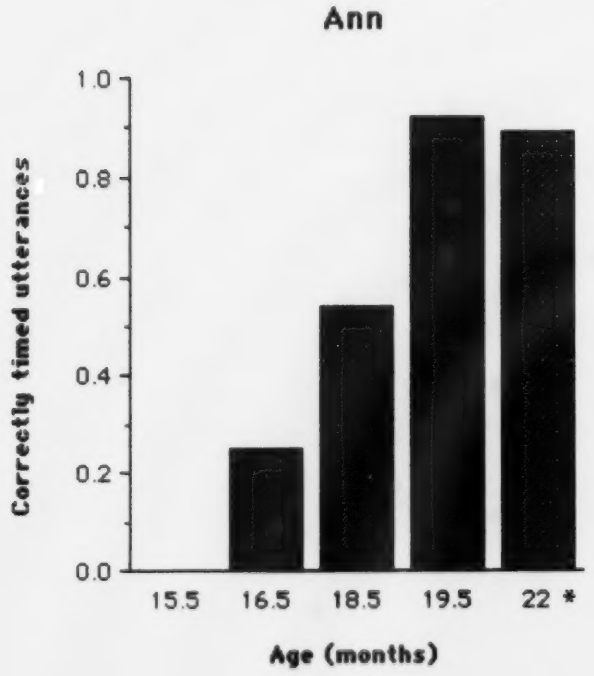


* First evidence of two-word combinations

Figure 3

Proportion of Correctly Timed Utterances
(divided by the total number of coded utterances)





*First evidence of two-word combinations

Table 1

Relationship Between the Information Conveyed in Gesture and the Information Conveyed in Speech

Beth

Age (in months)	Gesture with Meaningless Vocalization	Gesture Matches Speech	Gesture Mismatches Speech	Total Number of Gesure-Speech Combinations
14.5	1.00			7
16	.96	.02	.02	54
18*	.81	.07	.11	23

Ann

Age (in months)	Gesture with Meaningless Vocalization	Gesture Matches Speech	Gesture Mismatches Speech	Total Number of Gesure-Speech Combinations
15.5	1.00			2
16	1.00			30
18.5	.86	.12	.02	96
19.5	.69	.29	.02	49
22*	.60	.27	.13	159

Figure 4

Proportion of Gesture-Speech Combinations that are Mismatches